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(71) Applicant: ENERGY AND ENVIRONMENTAL TECHNOLOGIES CORP. [US/US]; P.O. Box 15014, Santa Rosa, CA 95402 (US).

(72) Inventor: JORDAN, John; P.O. Box 1257, Oldsmar, FL 34677 (US).

(74) Agents: BERKLEY, Richard, G. et al.; Brumaugh, Graves, Donohue & Raymond, 30 Rockefeller Plaza, New York, NY 10112 (US).

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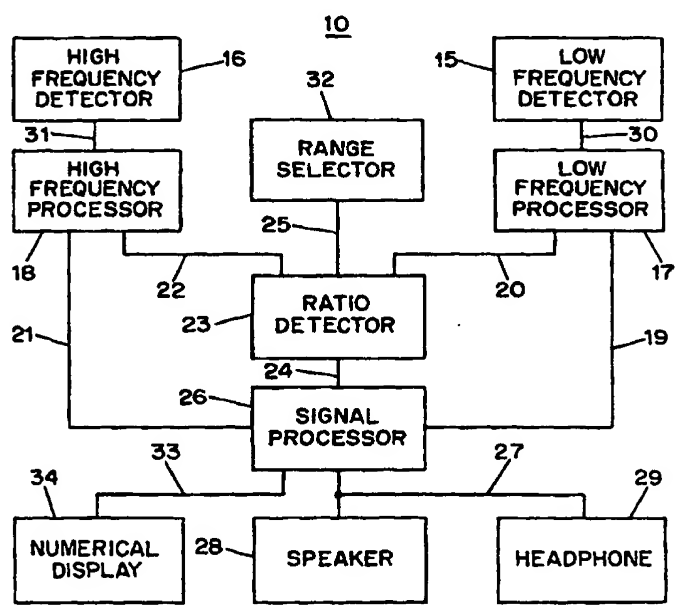
(54) Title: APPARATUS AND METHOD FOR DETECTING ULTRASONIC WAVES PROPAGATED FROM WITHIN A SELECTED DISTANCE

(57) Abstract

An ultrasonic leak detector (10) which discriminates against leak signals originating from outside a desired detection zone. Incoming ultrasonic waves are divided into mutually exclusive low (30) and high (31) frequency signals which are processed to form an intensity ratio (24). The intensity ratio is compared to a pre-selected ratio (25), and the leak signals originating from outside the desired detection zone are ignored. The presence of a leak is indicated by audio (29, 34) and visual (34) devices.



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Description

Apparatus and Method for Detecting Ultrasonic Waves Propagated from Within a Selected Distance

Field of the Invention

The present invention relates in general to ultrasonic source detection systems, and in particular, to an ultrasonic source detection system that processes ultrasonic signals received from two mutually exclusive frequency spectrums, thereby enabling the system to detect signals originating from within a desired detection zone, while ignoring signals emanating from outside the desired detection zone.

Background of the Invention

Detection of ultrasonic signals can be useful in various situations. A common example is the detection of leaks in equipment using compressed air or other gases, such as lines and hoses used to supply compressed air to pneumatic power tools and equipment in industrial settings. Leaks can occur as a result of cuts or cracks in the lines, and ultrasonic waves are generated as compressed air escapes through a cut or crack. For reasons of safety and economy it is essential that compressed air lines be continuously monitored for defects.

A basic knowledge of sound wave principles is necessary for the understanding of the process of detecting leaks by analyzing ultrasonic waves. The audible sound wave spectrum covers wave frequencies beginning at 20 Hz and ending at 20 KHz. Waves with higher frequencies are considered ultrasonic. Sound emanating from a source will typically be a composite of waves over a wide frequency range. As a wave

travels farther away from its source it attenuates or flattens out, and it is well known in the art that higher frequency waves attenuate at faster rates than low frequency waves.

Numerous prior art devices have been developed to detect leaks. U.S. Patent No. 3,462,240 discloses an instrument which detects and amplifies acoustic vibrations caused by fluid flowing through a hole in a pipeline. It divides the vibrations into high and low frequencies, and produces an alarm when one signal band generates a higher intensity than the other signal band.

U.S. Patent No. 5,040,409 provides for an apparatus and method for detecting when a pipe break in a sprinkler system occurs. This device also generates an alarm when one band produces a higher intensity reading than the other band.

U.S. Patent No. 4,635,042 shows a device for locating the sources of ultrasonic sound within a narrow frequency band indigenous to vacuum leaks through the utilization of a hand-held probe containing a transducer exhibiting a sensitivity peak within the band at about 40 KHz, and at least one other sensitivity peak outside the narrow band.

U.S. Patents Nos. 4,289,019, 4,785,659, 4,858,462 and 4,958,296 also propose devices for detecting leaks in pipes or hoses.

While the foregoing devices are effective in detecting leaks and are in widespread use, they are subject to high levels of interference originating from other sources and often give false indications of a leak in response to detection of ultrasonic signals from sources other than gas leaks that are commonly present in industrial environments. Moreover, when two ultrasonic leaks exist simultaneously, previously known devices are often incapable of distinguishing between

leaks within the desired detection zone and leaks outside the desired detection zone.

Accordingly, it is desirable to have an ultrasonic leak detector apparatus that can distinguish between simultaneous leaks within a selected detection zone and leaks outside the zone, and eliminate additional interference to indicate only sources within the selected zone.

Summary of the Invention

The present invention is an apparatus and method to distinguish ultrasonic waves propagating from within a desired distance while discriminating against ultrasonic sources transmitted from outside the desired detection area. The invention will produce an output signal which represents only the ultrasonic waves propagated from within the desired distance.

The preferred embodiment of the device for detecting ultrasonic waves within a desired detection zone includes low and high detectors sensitive to mutually exclusive frequencies, signal processors for producing normalized intensity and frequency signals in the respective channels, a ratio detector which continuously compares the ratio of the normalized low and high intensity signals to selected ratios thereby producing amplitude signals indicating the intensity of signals within the selected range and correcting for signals outside the range, and signal processors which process the frequency signals and the amplitude signals to produce an output signal indicative of the ultrasonic leak with background interference removed.

It is a further object of the present invention to provide a system with an adjustable ratio detector allowing the user to vary the size of the detection zone to meet a wide range of applications and detection distances.

It is another object of the present invention to provide a system with a numerical display whose scale is repeatable and directly proportional to the intensity of the incident ultrasound with the interference from ultrasound waves outside a selected zone removed.

It is yet a further object of the present invention to provide a system with an audible output allowing the user to hear sounds representative of the intensity and frequency variations in ultrasonic signals with the interference removed.

Brief Description of the Drawing

Further objects, features and advantages of the invention will become apparent from the following detailed description taken in conjunction with the accompanying figures showing a preferred embodiment of the invention, on which:

Fig. 1 is a schematic diagram of an ultrasonic wave detection apparatus in accordance with the invention;

Fig. 2 is a schematic diagram of the ratio detector portion of the apparatus; and

Fig. 3 is a flow chart illustrating a process in the ratio detector of Fig. 2.

Description of an Embodiment

The present invention is directed to an apparatus for ultrasonic source detection which ignores ultrasonic leaks emanating outside a desired detection zone. The invention applies the principle that high frequency waves attenuate more rapidly than low frequency waves to significantly improve ultrasonic wave detection. At an established distance, a predictable attenuation ratio can be developed by comparing the high frequency attenuation at that

distance to the low frequency attenuation at that distance.

Since high frequency waves attenuate more rapidly, the attenuation ratio will decrease as the ultrasonic waves travel farther from the source. Thus a compressed air leak at five feet away will have a higher ratio than a leak at twenty five feet away. The high frequency wave at five feet will have attenuated less with respect to its corresponding low frequency wave than at twenty five feet.

Figure 1 is a schematic diagram of an ultrasonic wave detection apparatus in accordance with the invention. Apparatus 10 comprises two detectors monitoring mutually exclusive frequencies. Low frequency detector 15 monitors ultrasonic waves in the low frequency spectrum (e.g., 30-40 kHz.) producing low frequency signal 30, and high frequency detector 16 monitors ultrasonic waves in the high frequency spectrum (e.g., 40-50 kHz.) producing high frequency signal 31. Detectors 15 and 16 comprise piezoelectric transducers in this preferred embodiment.

In a manner more fully described below, signal processing means 17 in the low frequency band continuously processes low frequency signal 30 to produce corresponding intensity signal 20 and amplified frequency signal 19, which correspond to the low frequency signals produced at the ultrasonic source, and signal processing means 18 in the high frequency band continuously processes high frequency signal 31 to produce corresponding intensity signal 22 and amplified frequency signal 21, which correspond to the high frequency signals produced at the ultrasonic source. Processing means 17, 18 can each comprise an operational amplifier whose input is connected to respective frequency signals 30, 31. Each operational amplifier's output is connected to a scaler (not shown)

in series to produce the corresponding normalized low frequency intensity signal 20 and high frequency intensity signal 22. Each operational amplifier's output signal is also connected to a voltage to frequency (V-to-F) converter (not shown) to produce the respective amplified frequency signals 19, 21. Intensity signals 20, 22 are connected to ratio detector 23 and amplified frequency signals 19, 21 are connected to signal processor 26. Processing means 17, 18 can also include a feedback loop that automatically adjusts the amplifier gain with reference to the level of the incident ultrasonic source. The amplifier preferably has a constant high gain..

Ratio detector 23 forms intensity ratios by dividing normalized high frequency intensity 22 by low frequency intensity 20 and compares them to a selected ratio which corresponds to the expected attenuation rates of the low and high frequency signals at an established distance. The selected distance is chosen by range selector means 32 such as a switch located on an external surface of apparatus 10 that produces range signal 25 indicating the desired range of detection. Range selector means 32 can also be an attachable keyboard that communicates with ratio detector 23. Ratio detector 23 then produces an amplitude signal 24 indicative of only the leaks emanating from within the selected range and based on a comparison of the ratios described in more detail below.

When a leak exists within the desired detection zone, signal processor 26 produces a representative output 33 representative of the intensity of the detected ultrasonic wave without interference. As shown in Fig. 1, the output 33 is applied to a numerical display 34, which is of conventional design with a repeatable scale and is directly proportional to the intensity of the incident ultrasound with the

interference from the ultrasound waves outside a selected zone removed. Signal processor 26 also reduces the frequency to an audible range and produces a second output 27 which is a representative audible tone varied in frequency and intensity relative to the incident ultrasonic source. Audible output 27 is then connected to speaker 28 or headphones 29 of conventional design.

Figure 2 is a block diagram of ratio detector 23. Ratio detector 23 contains microprocessor 50, which performs, inter alia, data retrieval from memory 52 and comparisons between the retrieved data and a ratio of the inputs. Microprocessor 50 is connected to memory 52 and to analog to digital (A/D) converters 56 and 58 which convert the incoming analog signals 20 and 22 to digital signals 60 and 62, respectively. The microprocessor 50 also receives as an input the selected range signal 25. Leads 54 connect microprocessor 50 to memory 52. Leads 60 and 62 connect microprocessor 50 to low frequency A/D converter 60 and high frequency A/D converter 62, respectively. Memory 52 can comprise a programmable read only memory (PROM) chip of conventional design. As depicted in Fig. 2, the microprocessor 50 generates amplitude signal 24 as an output, which is indicative of the intensity of the detected ultrasonic waves emanating within the selected distance zone.

Figure 3 describes the process employed in ratio detector 23 shown in Figure 2. In step 102, A/D converters 60 and 62 convert the analog intensity signals to equivalent digital signals to make them compatible with the inputs of microprocessor 50. Microprocessor 50 then processes the signals and creates an intensity ratio by dividing the high frequency intensity signal 22 by the low frequency intensity signal 20 in step 104. In step 106,

microprocessor 50 retrieves the chosen ratio stored in memory 52 based on the selected range signal 25 which corresponds to the chosen range of detection. Thus if a five foot range is selected, the associated selected ratio will be different than if a 20 foot range is selected. The ratios stored in memory 52 are entered prior to the detection process and can be established through controlled testing. Therefore, the detection zones can be completely user defined based upon the ratios entered for a given application.

Microprocessor 50 then compares the intensity ratio with the selected ratio in step 108. If the intensity ratio is greater than or equals the selected ratio, the detected ultrasonic signal is known to be generated from within the selected range because of the level of attenuation, and, as indicated in step 109, ratio detector 23 generates an amplitude signal 24 whose amplitude is representative of the intensity of the detected ultrasonic waves. Therefore, the amplitude of amplitude signal 24 is directly proportional to either the high frequency intensity signal 20 or the low frequency signal 22, both of which are inputs to ratio detector 23. The amplitude signal 24 will then be displayed on selected display devices. If the intensity ratio is less than the selected ratio, the process continues. In step 110, if the intensity ratio is greater than or equal to the selected ratio less a specified percentage (10% in this preferred embodiment), this indicates some interference from another source or general noise and the intensity signal 20 or 22 is reduced by the proportional difference of the ratios to produce an amplitude signal 24 that corresponds to the selected ratio in step 112. This eliminates any noise or other signal source outside the desired range causing interference. If the intensity ratio is less than a selected ratio less a

specified percentage in step 110, then the ultrasonic wave is emanating solely from a source outside the selected range which is established from the high level of attenuation. In step 114, amplitude signal 24 is given a zero value to indicate no leaks have been identified in the desired detection zone.

The foregoing merely illustrates the principles of the invention. It will thus be appreciated that those skilled in the art will be able to devise numerous systems and methods which, although not explicitly shown or described herein, embody the principles of the invention and are thus within the spirit and scope of the invention.

For example, a person skilled in the art may use one detector in place of detectors 15 and 16. The apparatus could then include high and low frequency band pass filters of a conventional design to separate the high frequency ultrasonic waves from the low frequency ultrasonic waves. In a similar manner, signal processing means 17 and 18 could be combined into one means with additional inputs and outputs to process both high and low ultrasonic frequency signals.

Alternatively, signal processing means 17 and 18 could be incorporated digitally into the programming of ratio detector 23. This would enable the frequency signals 30 and 31 to be modified digitally using conventional digital signal processing techniques after they have passed through the A/D converters 56 and 58. This could be beneficial to minimize components failures.

Finally, the present invention has been described and disclosed in a form in which the various system functions are performed by discrete functional blocks. However, any one or more of these functions could equally well be performed by one or more appropriately programmed microprocessors, micro-coded chips, etc.

Claims

1. An ultrasonic wave detection apparatus comprising:

detection means for sensing ultrasonic waves and generating a first input signal produced from a selected lower range of frequencies from the ultrasonic waves and a second input signal produced from a selected higher range of frequencies from the ultrasonic waves;

processing means for processing said first input signal to produce a first frequency signal and a first normalized intensity signal indicative of the frequency and the intensity of said first input signal, respectively, and for processing said second input signal to produce a second frequency signal and a second normalized intensity signal indicative of the frequency and the intensity of the second input signal, respectively;

means for continuously comparing said first and second normalized intensity signals and producing a third signal indicative of an intensity ratio of the first and second normalized intensity signals;

means for selecting a desired distance from the detection apparatus within which the ultrasonic waves propagated from within said desired distance will be displayed;

means for generating a fourth signal indicative of an expected intensity ratio corresponding to ultrasonic waves propagated from a source located at said desired distance from said apparatus;

means for continuously comparing said third signal to said fourth signal and producing a fifth

signal responsive to both said comparison and said first or second normalized intensity signals;

means for processing said first and second frequency signals and said fifth signal to produce an output signal; and

a notification means responsive to said output signal for producing an output indicative of said first or second input signals propagated within said desired distance of said apparatus without interference.

2. The apparatus according to claim 1 wherein said detecting means comprises a low frequency detecting means for producing said first input signal and a high frequency detecting means for producing said second input signal.

3. The apparatus according to claim 1 wherein said processing means comprises a low frequency processing means to process said first input signal and a high frequency processing means to process said second input signal.

4. The apparatus according to claim 1 wherein said notification means comprises a visual indicator.

5. The apparatus according to claim 1 wherein said notification means comprises an audible indicator.

6. The apparatus according to claim 1 wherein said generating means comprises:

means for storing at least one said expected intensity ratio; and

means for accessing at least one said expected intensity ratio responsive to said desired distance.

7. The apparatus according to claim 6 wherein said storing means comprises a programmable read only memory (PROM) chip.

8. The method of identifying ultrasonic waves originating within a specified distance comprising the steps of:

generating a first ratio from the intensity of the high frequency ultrasonic waves to the low frequency ultrasonic waves;

generating a second ratio indicative of the expected intensity ratio at said selected distance; and

comparing continuously said first and second ratios and producing output signal responsive to said comparison and indicative of said ultrasonic waves within said specified distance.

9. An ultrasonic wave detection method comprising the steps of:

sensing ultrasonic waves and generating a first input signal produced from a selected lower range of frequencies from the ultrasonic waves and a second input signal produced from a selected higher range of frequencies from the ultrasonic waves;

processing said first input signal to produce a first frequency signal and a first normalized intensity signal indicative of the frequency and the intensity of said first input signal, respectively, and processing said second input signal to produce a second frequency signal and a second normalized intensity signal indicative of the frequency and the intensity of the second input signal, respectively;

comparing continuously said first and second normalized intensity signals and producing a third signal indicative of an intensity ratio of the first and second normalized intensity signals;

selecting a desired distance from the detection apparatus within which the ultrasonic waves propagated from within said desired distance will be displayed;

generating a fourth signal indicative of an expected intensity ratio corresponding to ultrasonic waves propagated from a source located at said desired distance from said apparatus;

comparing continuously said third signal to said fourth signal and producing a fifth signal responsive to both said comparison and said first or second intensity signals;

processing said first and second frequency signals and said fifth signal to produce an output signal; and

producing an output responsive to said output signal indicative of said first or second input signals propagated within said desired distance of said apparatus without interference.

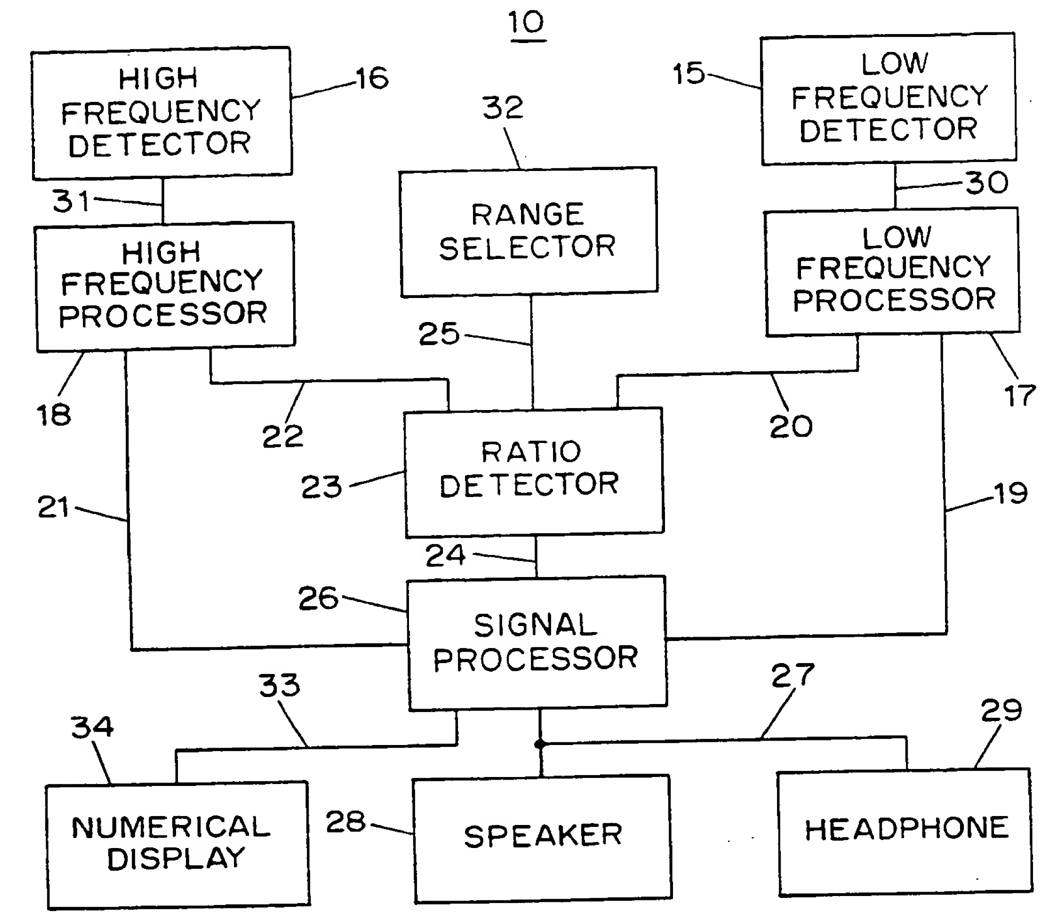
10
HIGH FREQUENCY DETECTOR
16
15
LOW FREQUENCY DETECTOR
32
RANGE SELECTOR
31
30
HIGH FREQUENCY PROCESSOR
LOW FREQUENCY PROCESSOR
25
17
18
22
20
RATIO DETECTOR
23
21
19
24
26
SIGNAL PROCESSOR
33
27
34
29
NUMERICAL DISPLAY
28
SPEAKER
HEADPHONE

FIG. 1

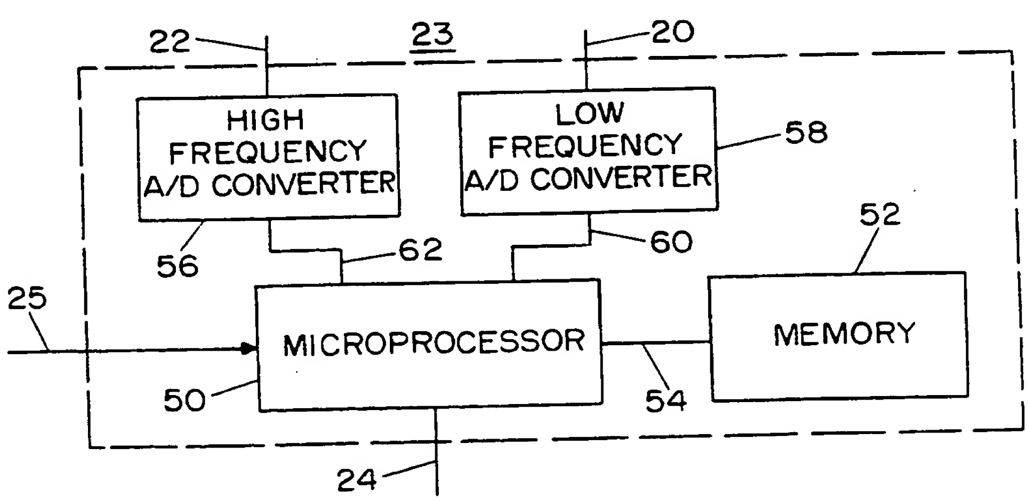
22
23
20
HIGH FREQUENCY A/D CONVERTER
LOW FREQUENCY A/D CONVERTER
58
52
56
62
60
25
MICROPROCESSOR
MEMORY
50
54
24

FIG. 2

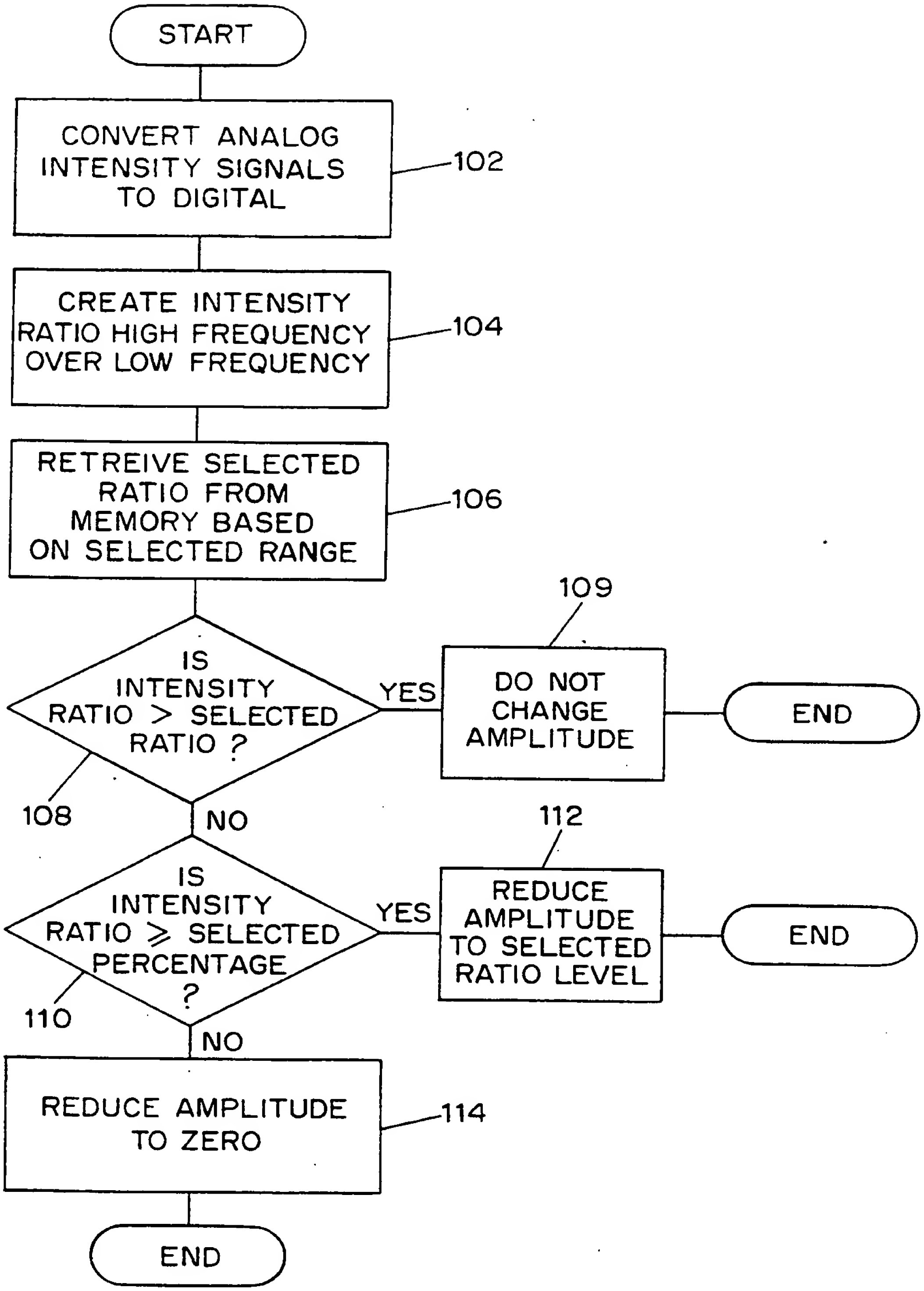
START
CONVERT ANALOG INTENSITY SIGNALS TO DIGITAL
102
CREATE INTENSITY RATIO HIGH FREQUENCY OVER LOW FREQUENCY
104
RETREIVE SELECTED RATIO FROM MEMORY BASED ON SELECTED RANGE
106
109
IS INTENSITY RATIO > SELECTED RATIO ?
YES
DO NOT CHANGE AMPLITUDE
END
108
NO
112
IS INTENSITY RATIO ≥ SELECTED PERCENTAGE ?
YES
REDUCE AMPLITUDE TO SELECTED RATIO LEVEL
END
110
NO
REDUCE AMPLITUDE TO ZERO
114
END

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 95/02904

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G01H3/08 G01M3/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G01H G01M G01V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE-A-31 01 928 (MESSERSCHMITT BOELKOW BLOHM) 5 August 1982 see the whole document ---	1,8
Y	US-A-3 903 729 (COVINGTON MORRIS T) 9 September 1975 see abstract; claims 1,3,5 ---	1,8
A	US-A-4 287 581 (NEALE SR DORY J) 1 September 1981 see abstract; figure 3 ---	4,5
A	FR-A-1 530 919 (SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ N.V.) 24 October 1968 --- -/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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3

Date of the actual completion of the international search	Date of mailing of the international search report
30 June 1995	26.07.95
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Authorized officer de Heering, P

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US-A-4 201 092 (DAU GARY J) 6 May 1980 see column 1, line 29 - column 2, line 5; claim; figure 2 ---	1
A	PATENT ABSTRACTS OF JAPAN vol. 011 no. 129 (P-570) ,23 April 1987 & JP,A,61 271476 (NEC CORP) 1 December 1986, see abstract ---	1,8
A	PATENT ABSTRACTS OF JAPAN vol. 013 no. 329 (P-904) ,25 July 1989 & JP,A,01 094205 (HITACHI CONSTR MACH CO LTD) 12 April 1989, see abstract -----	1,8

3

INTERNATIONAL SEARCH REPORT

Int .uonal Application No
PCT/US 95/02904

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US-A-3903729	09-09-75	CA-A- 1010554	17-05-77
		DE-A- 2414453	24-10-74
		GB-A- 1438237	03-06-76
		JP-A- 50002990	13-01-75
		CA-A- 963143	18-02-75
		DE-A- 2162708	27-07-72
		DE-B- 2167142	19-06-80
		GB-A- 1374797	20-11-74
US-A-4287581	01-09-81	NONE	
FR-A-1530919	24-10-68	AT-A- 290167	15-03-71
		CH-A- 486017	15-02-70
		DE-A- 1650173	10-09-70
		GB-A- 1149284	
		NL-A- 6609733	15-01-68
		US-A- 3462240	19-08-69
US-A-4201092	06-05-80	NONE	

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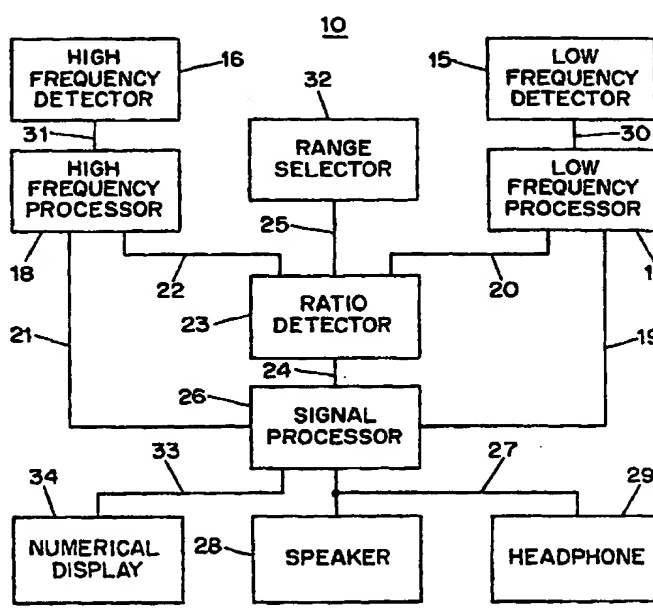
(54) Title: APPARATUS AND METHOD FOR DETECTING ULTRASONIC WAVES PROPAGATED FROM WITHIN A SELECTED DISTANCE

(57) Abstract

An ultrasonic leak detector (10) which discriminates against leak signals originating from outside a desired detection zone. Incoming ultrasonic waves are divided into mutually exclusive low (30) and high (31) frequency signals which are processed to form an intensity ratio (24). The intensity ratio is compared to a pre-selected ratio (25), and the leak signals originating from outside the desired detection zone are ignored. The presence of a leak is indicated by audio (29, 34) and visual (34) devices.



AMENDED CLAIMS

[received by the International Bureau on 26 September 1995 (26.09.95);
original claims 1-9 replaced by amended claims 1-18 (8 pages)]

1. An ultrasonic wave detection apparatus, comprising:

means for detecting ultrasonic waves and generating a first input signal responsive to said ultrasonic waves of a selected low frequency and for generating a second input signal responsive to said ultrasonic waves of a selected high frequency, wherein said selected low and high frequencies are mutually exclusive;

means for processing said first input signal to produce a first frequency signal and a first intensity signal indicative of the frequency and the intensity, respectively, of said first input signal and for processing said second input signal to produce a second frequency signal and a second intensity signal indicative of the frequency and the intensity, respectively, of the second input signal;

means for continuously comparing said first and second intensity signals and producing a third signal indicative of an intensity ratio of the first and second intensity signals;

means for selecting a distance from the detection apparatus wherein only ultrasonic waves propagated from a source located within said desired distance will be indicated by said apparatus;

means for generating a fourth signal indicative of an expected intensity ratio corresponding to low frequency and high frequency ultrasonic waves propagated from a source located at said selected distance from said apparatus;

means for continuously comparing said third signal and said fourth signal, and when a

predetermined relationship exists between said intensity ratio of said first and second intensity signals and said expected ratio signal, producing a fifth signal representative of the intensity of at least one of said first and second intensity signals;

means for processing at least one of said first and second frequency signals and said fifth signal to produce an output signal; and

notification means responsive to said output signal for producing an output indicative of at least one of said first and second input signals propagated from a source located within said selected distance of said apparatus without interference.

2. The apparatus according to claim 1, wherein said detection means comprises a low frequency detecting means for producing said first input signal and a high frequency detection means for producing said second input signal.

3. The apparatus according to claim 1, wherein said processing means comprises a low frequency processing means to process said first input signal and a high frequency processing means to process said second input signal.

4. The apparatus according to claim 1, wherein said notification means comprises at least one of a visual indicator and an audible indicator.

5. The apparatus according to claim 1, wherein said fourth signal generating means comprises:

means for storing at least one said expected intensity ratio; and

means for accessing said at least one expected intensity ratio in response to the selection of said selected distance by said selecting means.

6. The apparatus according to claim 5, wherein said storing means comprises a programmable read only memory (PROM) chip.

7. The apparatus of claim 1, wherein said fifth signal is representative of an average of said first and second intensity signals.

8. The apparatus of claim 1, wherein said notification means produces an output indicative of an average of said first and second frequency signals and an average of said first and second intensity signals.

9. The apparatus of claim 1, wherein when said intensity ratio of said first and second intensity signals is greater than or equal to said expected intensity ratio, said fifth signal is directly related to at least one of said first and second intensity signals.

10. The apparatus of claim 10, wherein when said intensity ratio of said first and second intensity signals is less than the expected intensity ratio and greater than or equal to said expected intensity ratio less a selected percentage, said fifth signal's amplitude is proportionally greater than at least one of said first and second intensity signals.

11. The apparatus in claim 11, wherein when said intensity ratio of said first and second intensity signals is less than the expected intensity ratio less a selected percentage, said fifth signal's amplitude is zero and no output signal is produced.

12. An ultrasonic wave detection method comprising the steps of:

detecting ultrasonic waves and generating a first input signal produced responsive to said ultrasonic waves of a selected low frequency and generating a second input signal produced responsive to said ultrasonic waves of a selected higher frequency, wherein said selected low and high frequencies are mutually exclusive;

processing said first input signal to produce a first frequency signal and a first intensity signal indicative of the frequency and the intensity, respectively, of said first input signal and processing said second signal to produce a second input frequency signal and a second intensity signal indicative of the frequency and the intensity, respectively, of the second input signal;

continuously comparing said first and second intensity signals and producing a third signal indicative of an intensity ratio of the first and second intensity signals;

selecting a distance from a detection apparatus which detects said ultrasonic waves wherein only ultrasonic waves propagated from a source located within said selected distance from said apparatus will be indicated;

generating a fourth signal indicative of an expected intensity ratio corresponding to low

frequency and high frequency ultrasonic waves propagated from a source located at said selected distance from the point of detection of the ultrasonic waves;

continuously comparing said third signal to said fourth signal and, when a predetermined relationship exists between said intensity ratio of said first and second intensity signals and said expected intensity ratio, producing a fifth signal representative of at least one of said first and second intensity signals;

processing said first and second frequency signals and said fifth signal to produce an output signal; and

producing an output responsive to said output signal indicative of at least one of said first and second input signals propagated from a source located within said selected distance.

13. The method of claim 13, wherein when said intensity ratio of said first and second intensity signals is greater than or equal to the expected intensity ratio, said fifth signal is directly related to at least one of said first and second intensity signal.

14. The method of claim 14, wherein when said intensity ratio of said first and second intensity signals is less than the expected intensity ratio and greater than or equal to said expected intensity ratio less a selected percentage, said fifth signal's amplitude is proportionally greater than at least one of said first and second intensity signals.

15. The method in claim 15, wherein when said intensity ratio of said first and second intensity signals is less than the expected intensity ratio less a selected percentage, said fifth signal's amplitude is zero and no output signal is produced.

16. The method of claim 13, wherein said fifth signal is representative of an average of said first and second intensity signals.

17. An ultrasonic wave detection apparatus comprising:

means for detecting ultrasonic waves and generating a first input signal responsive to said ultrasonic waves of a selected low frequency and for generating a second input signal responsive to said ultrasonic waves of a selected high frequency, wherein said selected low and high frequencies are mutually exclusive;

means for processing said first input signal to produce a first intensity signal indicative of the intensity of said first input signal and for processing said second input signal to produce a second intensity signal indicative of the intensity of the second input signal;

means for continuously comparing said first and second intensity signals and producing a third signal indicative of an intensity ratio of the first and second intensity signals;

means for selecting a distance from the detection apparatus within which sources of ultrasonic waves are to be indicated to the exclusion of sources beyond said distance;

means for generating a fourth signal indicative of an expected intensity ratio corresponding to low frequency and high frequency

ultrasonic waves propagated from a source located at said selected distance from said apparatus;

means for continuously comparing said third signal and said fourth signal, and when a predetermined relationship exists between said intensity ratio of said first and second intensity signals and said expected intensity ratio exists, producing a fifth signal indicative of at least one of said first and second intensity signals; and

notification means responsive to said fifth signal for producing an output indicative of at least one of said first and second intensity signals propagated from a source located within said selected distance of said apparatus without interference.

18. A method of identifying ultrasonic waves originating within a predetermined distance, comprising the steps of:

sensing ultrasonic waves having a high frequency component and a low frequency component;

separately determining an intensity of the high frequency component and an intensity of the low frequency component;

generating a first ratio of the intensity of the high frequency ultrasonic waves to the intensity of the low frequency ultrasonic waves;

generating a second ratio indicative of the expected intensity ratio at said predetermined distance; and

comparing continuously said first and second ratios and producing an output signal indicative of the detection of ultrasonic waves within said predetermined distance when a predetermined

AMENDED SHEET (ARTICLE 19)

relationship between said first and second ratios exists.